

**Title: The Role of Land-Cover Change in High Latitude Ecosystems:
Implications for Carbon Budgets in Northern North America**

Principal Investigator:

A. David McGuire
Institute of Arctic Biology
216 Irving I Building
University of Alaska Fairbanks
Fairbanks, AK 99775

ABSTRACT

The long-term goal of our current project in the Land Cover Land Cover Change Program (NAG5-6275; LCLUC-0016) is focused on the implications of land-cover change in high latitude ecosystems for the global carbon cycle. We have made substantial progress toward this goal through conducting change-detection studies of land-cover change in the Alaska region, and through developing a prototype spatially explicit modeling framework capable of using satellite-derived data to estimate how changes in land cover cause changes in ecosystem carbon storage in high latitudes. To take the next step towards our overall goal, we propose to (1) evaluate a key question that have emerged from our previous studies, and (2) to extend the application of our modeling framework to the entire Alaska-Canada region.

One question that emerged from our previous studies pertains to whether lakes and wetlands are drying up in the Alaska region, which may be indicative of large-scale decreases in soil moisture across Alaska. We hypothesize that there has been a significant decrease in the number of lakes and ponds in regions of discontinuous permafrost. We will test this hypothesis by comparing Landsat TM imagery from the 1980s with Landsat-7 ETM+ imagery from 2000. We will use scenes from an east-west climate gradient of Alaska. The areas range from maritime to continental climate regimes: Seward Peninsula, Innoko Flats, Tanana Flats, Forty Mile Flats, and the Yukon Flats. In addition, we will also study an area of continuous permafrost North Slope where we expect no significant loss of water bodies over the past 20 years.

The application of the modeling framework for the entire Alaska-Canada region will allow us to evaluate simulations of carbon dynamics for the region in the context of well-founded atmospheric inversion estimates, in the context of other regional estimates, and in the context of structural changes inferred from satellite-derived data. In comparison to Alaska, a greater array of disturbances and other factors, which include fire, insects, agricultural land use, timber harvest, and nitrogen deposition play a role in the carbon dynamics of Canada. Thus, the extension of our modeling efforts to simulate carbon dynamics for the Alaska-Canada region will involve further development of the modeling framework and development of spatially explicit data sets. Simulated carbon dynamics for the Alaska-Canada region will be compared estimates from a Bayesian time-dependent inversion analysis that we will use to estimate the inter-annual exchange of carbon for the region during the last two decades. At sub-regional scales, we will evaluate features of the simulations by the modeling framework with satellite-derived data sets. Features of the simulations available for comparison include net primary production, canopy carbon, total vegetation carbon, peak LAI, and the phenology of LAI. Satellite data sets available for

comparison include a long time series of coarse resolution (8 km and quarter degree) NDVI, LAI, and FAPAR derived from AVHRR data for the period July 1981 to December 1999. The comparison of features of our simulations with satellite-derived data in the context of atmospheric analyses should provide us with the ability to partition the temporal and spatial variability of the satellite-derived data to temporal and spatial variability in atmospheric CO₂, climate, disturbance, and nitrogen deposition.

Achievement of the objectives in the proposed study will improve our understanding of processes responsible for historical changes in carbon storage in high latitudes, will give us greater confidence in our ability to model those changes, and will give us the capability to evaluate how land-cover changes may affect carbon storage in high latitude regions in the future.